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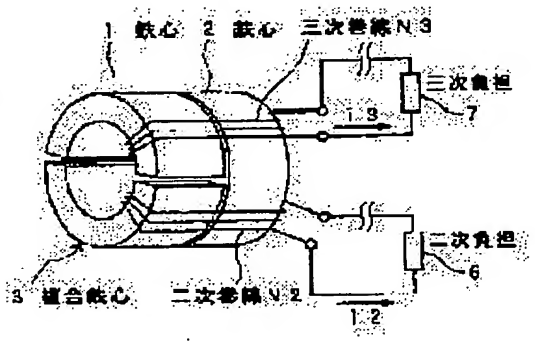
(54) CURRENT TRANSFORMER

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a current transformer which can be attached to a GIS, etc., without requiring measures for suppressing higher harmonics or work for preventing the occurrence of a short circuit between dummy winding terminals, and at the same time, satisfies both a residual magnetism characteristic and a residual current characteristic, while its main body is made more compact.
SOLUTION: A current transformer is provided with a composite core 3, formed by coaxially arranging a core 1 having a void and a closed core 2 by bringing the cores 1 and 2 into contact with each other, a secondary winding N2 wound around the core 3, and a zero-phase ternary winding N3 which is wound around the core 3 to constitute an opened delta connection by connecting three phases of windings in series. The composite core 3 is constituted by using grain-oriented silicon steel. The secondary winding N2 is wound on the zero- phase ternary winding N3 after the winding N2 is wound around the core 3, and then thermosetting insulating tape is wound on the secondary winding N2.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The current transformer characterized by having a 0 phase tertiary winding for making the iron core and closed iron core which have an opening contact mutually, and said compound iron core being looped around with the compound iron core arranged and formed on the same axle, and the secondary winding around which this compound iron core was looped, and carrying out series connection of the part for a three phase, and constituting open delta connection.
[Claim 2] The current transformer characterized by using a grain-oriented magnetic steel sheet for a compound iron core in a current transformer according to claim 1.
[Claim 3] The current transformer characterized by having looped the compound iron core around the 0 phase tertiary winding, and looping around a secondary winding on it in a current transformer according to claim 1 or 2.
[Claim 4] The current transformer characterized by having looped around and stiffened the thermosetting insulating tape and forming a sheathing insulating layer on the looped-around secondary winding in a current transformer according to claim 3.
[Claim 5] The current transformer characterized by carrying out the mold of the whole configuration member in one with resin in the current transformer of claim 1-4 given in any 1 term.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the current transformer which was excellent in the property of both a remnant magnetism property and a residual current property at one set in detail about the current transformer connected to the input section of various relays.
[0002]
[Description of the Prior Art] In order to make as small as possible remnant magnetism which causes malfunction at the time of the reclosing of a breaker, the current transformer which has an iron core with an opening, and the so-called current transformer with a remnant magnetism property are well used for the input sections, such as a biased relay which protects a generator and a motor. Since the primary current (for example, more than 800A) is the engine performance specified for a large through type current transformer, even if this current transformer with a remnant magnetism property has many secondary number of turns and the magnetizing force of an iron core with an opening and its property of iron loss are comparatively bad, it does not affect a ratio-of-current-transformation error so much.
[0003] On the other hand, when a ground overcurrent relay etc. detects the zero phase current (ground-fault current) of a power-transmission-wires-and-service-wires three-phase circuit, the zero-phase-sequence current transformer which detects the zero phase current to dedication is used, or it connects to three phase each track at a time one current transformer which formed the 0 phase tertiary winding N3 with the secondary winding N2 like drawing 4 , the residual circuit which carried out Y connection of the each second coil N2 is opened wide, and the zero phase current is passed to the tertiary winding N3. A residual circuit is a zero phase current circuit formed by connecting the neutral point of a current transformer, and the neutral points, such as a burden, here (see below-mentioned drawing 5).
[0004] In the circuit of drawing 4 , the closed circuit which opened the zero phase sequence component way by the residual circuit wide is formed by carrying out series connection of the zero phase each tertiary winding N3, and connecting the ground overcurrent relay OCG as a Miyoshi burden etc. In addition, the overcurrent relay as a secondary burden by which OC was connected to the secondary winding N2, the current on which IRa, ISa, and ITa flow an overcurrent relay OC, and I0 are the zero phase currents which flow the ground overcurrent relay OCG. In this case, the thing which is the need for the ground overcurrent relay OCG is only a current corresponding to a zero phase sequence component current, and the residual current which flows only according to a non-inverter and an opposition current is a useless current used as the factor which restricts about [being completely unnecessary] and detection sensitivity. Therefore, in order to make this residual current small, it is necessary to lessen dispersion and loss of an iron core property.
[0005] And in order to exclude the object for biased relays, the object for ground overcurrent relays, and the tooth space in which a current transformer is installed separately, respectively, the applicant of this invention has proposed JP,9-92560,A "a current transformer" as a current transformer with which are satisfied of both a remnant magnetism property and a residual current property. The secondary winding N2 to which the 1st iron core 11 which has an opening

was looped around this current transformer as shown in drawing 3 (only a part for one phase), It has simulation coil N2' which short-circuited between terminals so that the magnetic flux constituting the 0 phase tertiary winding N3 around which the 2nd iron core 12 which is a closed iron core was looped, and the cause of open circuit voltage by which induction is carried out to the 0 phase tertiary winding N3 might be negated and open circuit voltage might be controlled. The 1st iron core 11 and 2nd iron core 12 are arranged on the same axle, mold is further carried out with insulating resin, and the current transformer receipt unit section of a scale and a gas insulated switchgear (GIS) etc. is equipped with unification. In addition, 13 in drawing is a secondary burden and 14 is the Miyoshi burden, i2, i2', and a current on which i3 flows each coil N2, N2', and N3.

[0006]

[Problem(s) to be Solved by the Invention] By the way, the current transformer with which are satisfied of both the above-mentioned remnant magnetism property and a residual current property is the so-called duplex iron core form current transformer with which the coil with a remnant magnetism property and the 0 phase tertiary winding were equipped with the iron core of a proper, respectively, although it is unifying seemingly. Generally, it forms the closed circuit according to a residual circuit as shown in drawing 5 in order to prevent a higher harmonic and that the 3rd harmonic and the 5th harmonic are overlapped and a ratio-of-current-transformation error gets worse especially, in case one set connects not only with a coil with a remnant magnetism property but with three phase each track at a time and the current transformer with which the single iron core was looped around the single secondary winding carries out Y connection of the each second coil.

[0007] That is, harmonic content was made to flow back in a closed circuit, and the waveform distortion of a secondary-winding output is removed. Therefore, in case each phase bus-bar of GIS was made to penetrate and the current transformer receipt unit section, a switchboard, etc. were equipped with a current transformer, it was required to form a closed circuit or to connect a filter separately in a secondary-terminal terminal box. Moreover, the 0 phase tertiary-winding side also needed to short-circuit between the simulation coil terminals of a secondary-terminal terminal box with lead wire, dummy load, etc. Then, this invention excludes the activity of the cure for controlling a higher harmonic, the short circuit processing between simulation coil terminals, etc., and while making it possible to equip GIS etc., the body of a current transformer also tends to offer the current transformer with which it is [miniaturization] further satisfied of both a remnant magnetism property and a residual current property with a scale.

[0008]

[Means for Solving the Problem] This invention is equipped with the 0 phase tertiary winding for making the iron core and closed iron core which have an opening contact mutually, and said compound iron core being looped around with the compound iron core arranged and formed on the same axle, and the secondary winding around which this compound iron core was looped, and carrying out series connection of the part for a three phase, and constituting open delta connection. In addition, it is desirable to use a grain-oriented magnetic steel sheet for a compound iron core. Moreover, it is also possible to loop a compound iron core around a 0 phase tertiary winding, to loop around a secondary winding on it, to loop around and stiffen a thermosetting insulating tape on it further, and to form a sheathing insulating layer. As for this invention, it is desirable to carry out the mold of the above-mentioned whole configuration member in one with resin further again.

[0009]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained based on drawing. In order to show typically the secondary winding for one phase around which an iron core is looped in order that drawing 1 may explain the configuration of an operation gestalt plainly, and a 0 phase tertiary winding and to also make the function of a current transformer simple substance intelligible, Drawing which connected the direct burden to the secondary winding and the 0 phase tertiary winding (series connection of the part for a three phase is carried out, it connects with the Miyoshi burden 7, and a tertiary winding N3 forms a closed circuit.) It is carrying out, and further, insulation of winding etc. is omitted and only main

configurations are illustrated. In drawing, 1 is an iron core which has the opening which consists of a grain-oriented magnetic steel sheet, and although not illustrated into the gap part, the insulating papers, such as sheet metal of non-magnetic material, such as stainless steel, or polyester film, are inserted.

[0010] 2 is a closed iron core which consists of a grain-oriented magnetic steel sheet, is contacted by the iron core 1 and arranged on the same axle. The compound iron core 3 is formed of these iron cores 1 and an iron core 2. As shown in drawing 2 , after the iron core insulation 4 is performed to the outside surface of the compound iron core 3, it is looped around the 0 phase tertiary winding N3, and the Miyoshi burden 7 is connected to it. Furthermore, the insulation between layers (not shown) is performed, the perimeter is looped around a secondary winding N2 equally [a rear spring supporter], and the secondary burden 6 is connected. The 0 phase tertiary winding N3 is that number of turns loop the upper layer around the secondary winding N2 with many number of turns few (usually 20 turns), and a low voltage potential layer (touch-down potential) is formed for a current transformer peripheral surface of a secondary winding N2, and it is shielded. In addition, although the secondary winding N2 and the tertiary winding N3 are shown that the same layer is looped around by drawing 1 , an actual looping-around condition is as drawing 2 .

[0011] Moreover, after especially the secondary winding N2 is looped around, by looping around and stiffening a thermosetting insulating tape, the irregularity of the front face by the coil is lost, a cylindrical shape-like sheathing insulating layer is mostly formed for a front face, and the outside surface of a current transformer is finished flat and smooth. Moreover, as other configurations, although not illustrated, the whole configuration member of a current transformer may really be covered with an epoxy resin, and it may attach in a part of the front face, and a seat may be formed. By using this anchoring seat, in case a current transformer is installed, it becomes possible to fix a current transformer independently.

[0012] In this way, by having both looped the same compound iron core 3 around the 0 phase tertiary winding N3 and the secondary winding N2, when connecting one current transformer to three phase each track at a time, by carrying out series connection of the zero phase each tertiary winding N3, and connecting a ground overcurrent relay, a closed circuit is formed and a zero phase sequence component way (residual circuit) is opened. Harmonic content is made to flow back in the closed circuit of a tertiary winding N3 by that cause, and the waveform distortion of each coil output can be removed. Moreover, since the grain-oriented magnetic steel sheet was used for the compound iron core 3, respectively, when magnetizing force and iron loss fall as the iron core property, the effect of the variation in an iron core property decreases about the ratio-of-current-transformation error of a 0 phase tertiary winding.

[0013] That is, since it is the iron core of the property to which all three sets were equal even if the property of each iron core is bad to some extent, the ratio-of-current-transformation error of the 0 phase tertiary winding N3 becomes what has large tolerance compared with the ratio-of-current-transformation error of a secondary winding N2 relatively as a result. About the ingredient of an iron core, it becomes very [in cost] advantageous from these things because the tolerance of a property becomes large. When a production process specifically constitutes an iron core by being made from the grain-oriented magnetic steel sheet of the same lot, the property same about each iron core will be easy to be acquired.

[0014] However, when requirement specification is still severe, it is possible by manufacturing a compound iron core combining a permalloy and a grain-oriented magnetic steel sheet excellent in permeability, and raising a property to satisfy requirement specification. In addition, since it has the gap in the direction of a magnetic-path right angle of an iron core about the remnant magnetism property of an iron core, since there is no remnant magnetism and the specification with a remnant magnetism property is moreover specified as 30% or less of the saturation MAG, especially even when there is remnant magnetism in part, it hardly becomes a problem.

[0015]

[Effect of the Invention] In case GIS, a switchboard, etc. are equipped according to this invention since it is satisfied only with the body of a current transformer of both a remnant magnetism property and a residual current property as stated above, the troublesome activity of connecting

the simulation coil of a secondary-terminal terminal box with the coil side with a remnant magnetism property which was the need conventionally too hastily by the allowance which controls a higher harmonic wave, and the 0 phase tertiary-winding side becomes unnecessary. Moreover, since the compound iron core is looped around each coil after contacting mutually, arranging the iron core and closed iron core which have an opening on the same axle and making them into the iron core of one, the body of a current transformer is miniaturized compared with the so-called duplex iron core form current transformer of the former which loops around a coil for every iron core.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing having shown the configuration of this invention typically.
[Drawing 2] It is the sectional view having shown the configuration of this invention typically.
[Drawing 3] It is drawing having shown the configuration of the conventional example typically.
[Drawing 4] It is the example of installation of the conventional current transformer.
[Drawing 5] It is the example of installation of the conventional current transformer.
[Description of Notations]
1 Two Iron core
3 Compound Iron Core
4 Iron Core Insulation
6 Secondary Burden
7 Miyoshi Burden
N2 Secondary winding
N3 0 phase tertiary winding

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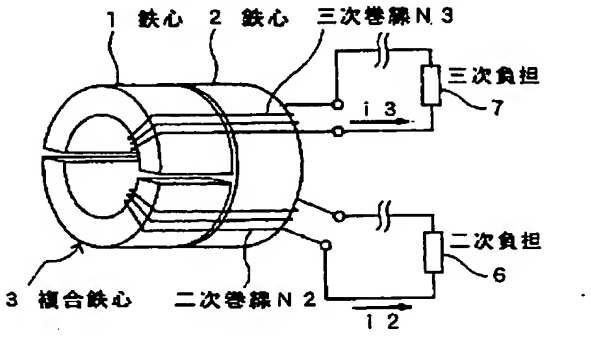
(54)【発明の名称】　変流器

(57)【要約】
【課題】　二重鉄心構造の変流器をGIS各相母線に貫通させて変流器収納ユニットに装着する場合に、閉回路を形成する等の残留磁気特性への対策が必要であった。
【解決手段】　空隙を有する鉄心１と閉鉄心２とを互いに当接させて同軸上に配置して形成された複合鉄心３と、この複合鉄心３に巻装された二次巻線N2と、前記複合鉄心３に巻装され、かつ三相分を直列接続して開放三角結線を構成するための零相三次巻線N3とを備えたものである。なお、複合鉄心３には、方向性珪素鋼板を用いる。また、複合鉄心３に零相三次巻線N3を巻装しその上に二次巻線N2を巻装し、その上に熱硬化性絶縁テープを巻装する。



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【特許請求の範囲】
【請求項１】　空隙を有する鉄心と閉鉄心とを互いに当接させて同軸上に配置して形成された複合鉄心と、
この複合鉄心に巻装された二次巻線と、
前記複合鉄心に巻装され、かつ三相分を直列接続して開放三角結線を構成するための零相三次巻線と、を備えたことを特徴とする変流器。
【請求項２】　請求項１記載の変流器において、
複合鉄心に方向性珪素鋼板を用いたことを特徴とする変流器。
【請求項３】　請求項１または２記載の変流器において、
複合鉄心に零相三次巻線を巻装しその上に二次巻線を巻装したことを特徴とする変流器。
【請求項４】　請求項３記載の変流器において、
巻装された二次巻線上に熱硬化性絶縁テープを巻装して硬化させ、外装絶縁層を形成したことを特徴とする変流器。
【請求項５】　請求項１～４のいずれか１項記載の変流器において、
構成部材の全体を、樹脂により一体的にモールドしたことを特徴とする変流器。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、各種継電器の入力部に接続される変流器に関し、詳しくは、１台で残留磁気特性及び残留電流特性の両方の特性にすぐれた変流器に関する。
【０００２】
【従来の技術】発電機や電動機を保護する比率差動継電器等の入力部には、遮断器の再投入時に誤動作の原因となる残留磁気をできるだけ小さくするために、空隙付き鉄心を有する変流器、いわゆる残留磁気特性付き変流器がよく用いられる。この残留磁気特性付き変流器は、一次電流（例えば、800A以上）が大きい貫通形変流器を対象に規定される性能なので、二次巻数が多く、空隙付き鉄心の磁化力および鉄損の特性が比較的悪くても変流比誤差にそれほど影響を与えない。
【０００３】一方、地絡過電流継電器等により送配電線三相回路の零相電流（地絡事故電流）を検出する場合には、零相電流を専用に検出する零相変流器を用いたり、あるいは図４のように、二次巻線N2と共に零相三次巻線N3を設けた変流器を三相各線路に１台ずつ接続して、各二次巻線N2をＹ結線した残留回路を開放し、三次巻線N3に零相電流を流している。ここで残留回路とは、変流器の中性点と負担などの中性点とを結ぶことにより形成される零相電流回路である（後述の図５を参照）。
【０００４】図４の回路では、各零相三次巻線N3を直列接続して三次負担としての地絡過電流継電器OCG等を接続することにより、残留回路による零相分路を開放した

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閉回路が形成される。なお、OCは二次巻線N2に接続された二次負担としての過電流継電器、I_{Ra}，I_{Sa}，I_{Ta}は過電流継電器OCを流れる電流、I_0は地絡過電流継電器OCGを流れる零相電流である。この場合、地絡過電流継電器OCGにとって必要なのは零相分電流に対応する電流のみであり、正相・逆相電流のみによって流れる残留電流は全く不要であるばかりか、検出感度を制限する要因となる無益な電流である。従って、この残留電流を小さくするためには、鉄心特性のばらつきや損失を少なくする必要がある。
【０００５】そして、比率差動継電器用と地絡過電流継電器用とそれぞれ別個に変流器を設置するスペースを省くため、残留磁気特性と残留電流特性の両方を満足する変流器として、本発明の出願人は、特開平9-92560号「変流器」を提案している。この変流器は、図３（一相分のみ）に示すように、空隙を有する第１の鉄心11に巻装された二次巻線N2と、閉鉄心である第２の鉄心12に巻装された零相三次巻線N3と、その零相三次巻線N3に誘起される開放電圧の原因となる磁束を打ち消して開放電圧を抑制するように端子間を短絡した模擬巻線N2'を備えて、第１の鉄心11と第２の鉄心12を同軸上に配置し、さらに絶縁樹脂によりモールドして一体化をはかり、ガス絶縁開閉装置（GIS）の変流器収納ユニット部等に装着するようにしたものである。なお、図中の13は二次負担、14は三次負担、i2,i2',i3は各巻線N2,N2',N3を流れる電流である。
【０００６】
【発明が解決しようとする課題】ところで、上記の残留磁気特性と残留電流特性の両方を満足する変流器は、見掛け上一体化しているものの、残留磁気特性付き巻線と零相三次巻線が、それぞれ固有の鉄心を備えた、いわゆる二重鉄心形変流器である。一般的に、単一鉄心に単一の二次巻線が巻装された変流器は、残留磁気特性付き巻線に限らず、三相各線路に１台ずつ接続して各二次巻線をＹ結線する際、高調波、特に第３調波と第５調波が重畳して変流比誤差が悪化するのを防止するため、図５に示すような残留回路に準じた閉回路を形成している。
【０００７】つまり、高調波成分を閉回路で還流させて、二次巻線出力の波形歪を取り除いている。従って、変流器をGISの各相母線に貫通させて変流器収納ユニット部や配電盤等に装着する際、二次端子ターミナルボックスにおいて閉回路を形成したり、あるいは別途フィルタを接続することが必要であった。又零相三次巻線側でも二次端子ターミナルボックスの模擬巻線端子間を導線や模擬負荷等で短絡する必要があった。そこで、本発明は、高調波を抑制するための対策や、模擬巻線端子間の短絡処理等の作業を省いて、GIS等へ装着することを可能にするとともに、変流器本体も更にコンパクト化をはかりながら、残留磁気特性と残留電流特性の両方を満足する変流器を提供しようとするものである。

【０００８】
【課題を解決するための手段】本発明は、空隙を有する鉄心と閉鉄心とを互いに当接させて同軸上に配置して形成された複合鉄心と、この複合鉄心に巻装された二次巻線と、前記複合鉄心に巻装され、かつ三相分を直列接続して開放三角結線を構成するための零相三次巻線とを備えたものである。なお、複合鉄心には、方向性珪素鋼板を用いることが好ましい。また、複合鉄心に零相三次巻線を巻装しその上に二次巻線を巻装し、さらにその上に熱硬化性絶縁テープを巻装して硬化させ、外装絶縁層を形成することも可能である。さらにまた、本発明は、上記構成部材の全体を樹脂により一体的にモールドすることが望ましい。
【０００９】
【発明の実施の形態】以下、図に基づき本発明の実施形態を説明する。図１は実施形態の構成をわかりやすく説明するため、鉄心に巻装される一相分の二次巻線、零相三次巻線を模式的に示したものであり、又、変流器単体の機能もわかりやすくするため、二次巻線、零相三次巻線に直接負担を接続した図（三次巻線N3は三相分が直列接続されて三次負担７に接続され、閉回路を形成する。）としており、さらに、巻線絶縁等を省略し主要構成のみ図示している。図において、１は方向性珪素鋼板からなる空隙を有する鉄心であり、そのギャップ部分に図示しないがステンレス等の非磁性体の薄板又はポリエステルフィルム等の絶縁紙が挿入されている。
【００１０】２は方向性珪素鋼板からなる閉じられた鉄心であり、鉄心１に当接されて同軸上に配設されている。これら鉄心１と鉄心２とにより複合鉄心３が形成される。複合鉄心３の外表面には、図２に示されるように、鉄心絶縁４が施されてから零相三次巻線N3が巻装されて、三次負担７が接続されている。更に、層間の絶縁（図示せず）を施して二次巻線N2が全周にわたり均等に巻装されて、二次負担６が接続されている。零相三次巻線N3は巻数が少なく（普通、20ターン）、巻数の多い二次巻線N2を上層に巻装することで、変流器周面が二次巻線N2により低圧電位層（接地電位）が形成されてシールドされる。なお、図１では二次巻線N2、三次巻線N3が同一の層に巻装されているように示されているが、実際の巻装状態は図２のとおりである。
【００１１】又、特に二次巻線N2が巻装された後、熱硬化性絶縁テープを巻装して硬化させることで、巻線による表面の凹凸が無くなり、表面がほぼ円筒形状の外装絶縁層が形成されて、変流器の外表面が平滑に仕上がる。また、他の構成として、図示しないが変流器の構成部材全体をエポキシ樹脂で一体被覆して、その表面の一部に取付け座を形成することもある。この取付け座を用いることで、変流器を設置する際は、変流器を単独で固定することが可能となる。
【００１２】こうして、零相三次巻線N3と二次巻線N2と

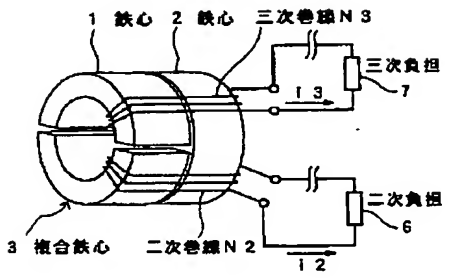
を共に同一の複合鉄心３に巻装したことで、変流器を三相各線路に１台ずつ接続する場合、各零相三次巻線N3を直列接続して地絡過電流継電器を接続することにより閉回路を形成し、零相分路（残留回路）を開放する。それにより三次巻線N3の閉回路で高調波成分を還流させて各巻線出力の波形歪を取り除くことができる。また複合鉄心３には、それぞれ方向性珪素鋼板を用いたので、その鉄心特性として磁化力および鉄損が低下することにより、零相三次巻線の変流比誤差について、鉄心特性のバラツキの影響が少なくなる。
【００１３】つまり各鉄心の特性がある程度悪くても、３台とも揃った特性の鉄心であることから、結果として零相三次巻線N3の変流比誤差は、相対的に二次巻線N2の変流比誤差に比べて許容範囲が大きいものとなる。これらのことから、鉄心の材料に関しては、特性の許容範囲が大きくなることでコスト的に極めて有利となる。具体的には、製造工程が同一のロットの方向性珪素鋼板を素材として鉄心を構成すると各鉄心について同一の特性が得られ易いことになる。
【００１４】しかし、それでもまだ要求仕様が厳しい場合は、透磁性にすぐれたパーマロイと方向性珪素鋼板とを組み合わせて複合鉄心を製作し、特性を向上させることにより要求仕様を満足させることが可能である。なお、鉄心の残留磁気特性については、鉄心の磁路直角方向にギャップを有しているため殆ど残留磁気は無く、しかも残留磁気特性付きの仕様が飽和磁気の30%以下と規定されているので、一部残留磁気がある場合でも特に問題となることはない。
【００１５】
【発明の効果】以上述べたように本発明によれば、変流器本体のみで残留磁気特性および残留電流特性がともに満足されるので、GISや配電盤等へ装着する際、従来必要であった残留磁気特性付き巻線側に高調波を抑制する手当てや、零相三次巻線側で二次端子ターミナルボックスの模擬巻線を短絡する等の煩わしい作業が不要となる。又、空隙を有する鉄心と閉鉄心とを互いに当接して同軸上に配置して、一体の鉄心としてから、その複合鉄心に各巻線を巻装するので、各鉄心毎に巻線を巻装する従来のいわゆる二重鉄心形変流器に比べて、変流器本体が小型化される。
【図面の簡単な説明】
【図１】本発明の構成を模式的に示した図である。
【図２】本発明の構成を模式的に示した断面図である。
【図３】従来例の構成を模式的に示した図である。
【図４】従来の変流器の設置例である。
【図５】従来の変流器の設置例である。
【符号の説明】
１，２　鉄心
３　複合鉄心
４　鉄心絶縁

5　　6

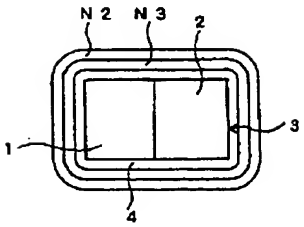
6　二次負担
7　三次負担

N2　二次巻線
N3　零相三次巻線

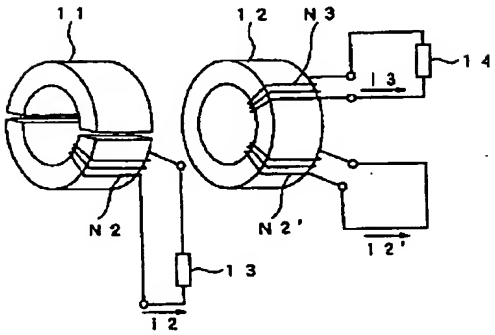
【図１】



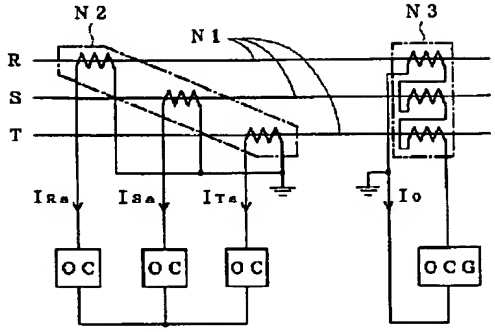
【図２】



【図３】



【図４】



【図５】